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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/051,906	01/16/2002	Chao-Yuan Su	67,200-630	1799

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EXAMINER	
RUGGLES, JOHN S	

ART UNIT	PAPER NUMBER
1756	2

DATE MAILED: 10/22/2003

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No. 10/051,906	Applicant(s) SU ET AL.	
	Examiner John Ruggles	Art Unit 1756	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *16 January 2002* .

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disp sition of Claims

4)☒ Claim(s) *1-20* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-20* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☒ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on *16 January 2002* is/are: a)☐ accepted or b)☒ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

11)☐ The proposed drawing correction filed on _____ is: a)☐ approved b)☐ disapproved by the Examiner.

If approved, corrected drawings are required in reply to this Office action.

12)☐ The oath or declaration is objected to by the Examiner.

Pri rity under 35 U.S.C. §§ 119 and 120

13)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____ .

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

14)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).

a) ☐ The translation of the foreign language provisional application has been received.

15)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachm nt(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s) _____ .
4) ☐ Interview Summary (PTO-413) Paper No(s). _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: .

DETAILED ACTION

Drawings

The drawings are objected to as failing to comply with 37 CFR 1.84(p)(4) because in Figures 2C and 2D, reference characters "20", "21", and "22" have all been used to designate the substrate 21, while the passivation layer 22 has been mislabeled "24A" and the under bump metallization (UBM) layer 24A has not been labeled at all. A proposed drawing correction or corrected drawings are required in reply to the Office action to avoid abandonment of the application. The objection to the drawings will not be held in abeyance.

Specification

35 U.S.C. 112, first paragraph, requires the specification to be written in "full, clear, concise, and exact terms." The specification is replete with terms, which are not clear, concise and exact. The specification should be revised carefully in order to comply with 35 U.S.C. 112, first paragraph. Examples of some unclear, inexact or verbose terms used in the specification are: (1) in line 3 of paragraph 001 on page 1, "including on flip chip bonding technology" should be changed to --in flip chip bonding technology--, to be grammatically correct; (2) both in lines 1-2 on page 7 and again in lines 3-4 of paragraph 0033 on page 19, "90 Pb/10 Sn (95/10)" must be corrected to --90 Pb/10 Sn (90/10)--, to be consistent; (3) in lines 1-2 of paragraph 0010 on page 8, "to provide to develop", should be rewritten (e.g., to --to provide or develop--, etc.), to more clearly set forth the object of applicants' invention; (4) at all three instances in paragraph 0029, benzocyclobutene has been abbreviated as "BCD", but should be changed to --BCB--, to better represent this compound as it is abbreviated in the prior art; and (5) in line 1 on page 17,

"over exposed UBM layer 24A (contact layer)" should be changed to --over exposed passivation layer 22--, because the protective layer 24C is described at the bottom of page 16 and shown in Figure 2E to be deposited over photoresist 24B and the exposed portion of the passivation layer 22. Note that due to the number of errors, those listed here are merely *examples* of the corrections needed and do *not* represent an exhaustive list thereof.

Appropriate correction is required. An amendment filed making all appropriate corrections must be accompanied by a statement that it contains no new matter.

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

Claims 1-20 are rejected under 35 U.S.C. 103(a) as being unpatentable over Costas, et al. (US Patent 6,137,125) in view of admitted prior art and further in view of Lee (US Patent 6,410,414).

Costas teaches a monolithic microwave integrated circuit (MMIC) and a process of making it, including flip-chip mounting of the MMIC (column 1, lines 6-8). The process involves spin coating, then patterning (by imaging and rinsing with a developer solvent, which encompasses wet chemical stripping) and curing of a benzocyclobutene (BCB) low dielectric film 10 on a processed MMIC wafer 1, as shown in Figures 2-3 (column 3, lines 34-54). Figure

4 shows overcoating with ceramic 401 (preferably silicon carbide (SiC) or silicon nitride) and Figure 5 shows reactive ion etching (RIE) of the ceramic 401, along with those portions of the remaining underlying BCB 10 on bond pads 6, through a patterned resist mask to open up underlying bond pads 6 and streets 5 of the MMIC wafer 1 (column 3, lines 54-66). Then, Figure 6 shows formation of solder bumps 601 on the bond pads 6 by either electroplating or evaporation through openings in the patterned ceramic 401 and BCB low dielectric film 10, both of these methods are well known to one of ordinary skill in the art (column 3, line 66 to column 4, line 2 and column 5, lines 25-26, this is equivalent to forming of solder columns through a patterned resist stencil either (1) of photosensitive BCB or (2) with underlying non-photosensitive BCB, which has been patterned through the resist stencil). The BCB low dielectric polymer 10 possesses mechanical, electrical, and chemical properties that make it compatible with MMIC fabrication (column 4, lines 8-10). Also, while the BCB low dielectric polymer 10 is preferably photosensitive to simplify photolithographic patterning of the BCB (column 4, lines 12-14), this is not required as indicated by a comparison of Figures 4 and 5, which show removal of BCB 10 over the bond pads 6 along with RIE of overlying ceramic 401 through a patterned resist. This clearly suggests that non-photosensitive BCB could also have been patterned by RIE through an overlying patterned resist layer, either as a separate etching step or together with etching of another layer, as shown. Other advantages of using BCB are that it provides sufficient resistance to moisture, which is increased by addition of an overlying patterned ceramic layer (e.g., SiC, etc.) and that it also provides excellent resistance to mechanical damage during subsequent processing, particularly during final assembly (column 4, lines 27-34, which is understood to include solder reflow for bonding of metal connections).

Costas does not specifically teach *(1)* the glass transition temperature (T_g) of the BCB low dielectric polymer protective layer, *(2)* thermal treatment for reflow of the solder bumps to form solder balls, *(3)* the composition of the solder used, *(4)* what metal(s) are included in the bond pads, or *(5)* RIE of the metal bond pads to reveal surrounding portions of an underlying passivation layer.

However, applicants have already admitted in instant Figures 1A-1E as described in instant paragraphs 006-007 on instant pages 4-7 that the following teachings were already known ***prior art*** at the time the instant invention was made: [a] forming a bonding pad 10 (e.g., Cu, Al, etc.) by vapor deposition on a semiconductor wafer 8, patterning a passivation layer 12 (e.g., SiN, SiO_2, etc.) overlying edge portions of the bonding pad 10 and adjacent areas of the substrate semiconductor wafer 8, covering with one or more under bump metallization (UBM) layers 14A (e.g., Ti, etc.) over the bonding pad 10 as shown in Figure 1A, patterning resist 16 having an opening 17 over the UBM layer(s) 14A on the bond pad 10 as shown in Figure 1B, forming additional UBM layers 14B (e.g., Cu, etc.) and 14C (e.g., Ni, etc.) over 14A in the opening 17 *(4)*, depositing solder 18A in opening 17 by either separate layers (e.g., Pb then Sn, etc.) followed by reflow to make them homogeneous as shown in Figure 1C or depositing homogeneous solder (by e.g., electroplating, vapor deposition, etc.), removal of resist 16, RIE of exposed UBM layer(s) down to passivation layer 12 as shown in Figure 1D *(5)*, and then reflow of the solder 18A to form solder bump or ball 18B as shown in Figure 1E *(2)*; and [b] using a high lead solder having a composition of 95% Pb/5% Sn (95 Pb/5 Sn) or 90 Pb/10 Sn (e.g., with melting temperatures in excess of 350 °C, etc.), which are reliable and particularly resistant to fatigue *(3)*.

Lee shows a semiconductor device and a process of fabricating the semiconductor device, particularly relating to chip scale packaging that involves photolithographic patterning and subsequent forming of solder bumps or balls for attachment of external connectors or terminals (column 1, lines 6-9 and 51-54). The process includes forming a patterned benzocyclobutene (BCB) layer 112 on a metal pattern 110 and a passivation layer 108, leaving openings to expose portions of metal 110 that correspond to external terminal pads 118, as shown in Figure 3 (column 3, lines 40-44). The BCB 112 is patterned by known photolithography and etching, which encompasses etching through a patterned resist, to mask an area for connection of a solder ball to the exposed metal 110. The BCB has a glass transition temperature (T_g) of approximately 60 °C higher than 290 °C, which is the T_g of polyimide (or the T_g for BCB is about 350 °C, ***(1)***). Thus, BCB is more stable in packaging processes performed at high temperatures (column 3, lines 45-60). Figure 4 shows subsequent reflow for attaching solder balls 114 to external terminal pads 118, which form external terminals for a chip scale package (CSP) suitable for mounting on a printed circuit board (column 3, lines 61-64). The inherent characteristics of BCB (e.g., low water intake, etc.) reduce defects caused by corrosion for enhancing reliability of the semiconductor package. Further, BCB has good high temperature stability to reduce damage during processing and low volatility to prevent corrosive byproducts during curing in order to allow stable overall fabrication (column 6, line 62 to column 7, line 5).

It would have been obvious to one of ordinary skill in the art at the time the invention was made to have conducted the photolithographic process of the instant claims in accordance with the known teachings of the admitted prior art as noted above along with patterning of a resist either (i) of or (ii) with BCB, as taught by Costas and shown by Lee, in which the BCB has

a T_g of about 350 °C (an inherent property of BCB shown by Lee, instant claims 1-7, 9-14, and 16-20) to allow subsequent reflow of high lead solder bumps or balls (e.g., 95 Pb/5 Sn, 90 Pb/10 Sn, etc., instant claims 8 and 15) without damage during processing (due to the protection afforded by the BCB) for the reasons discussed above, including those shown by Lee. The inherent characteristics of BCB (e.g., low water intake, etc.) reduce defects caused by corrosion for enhancing reliability of the semiconductor package. Further, BCB has good high temperature stability to reduce damage during processing and low volatility to prevent corrosive byproducts during curing in order to allow stable overall fabrication. Lee shows both of these reasons. Other advantages of using BCB are that it provides sufficient resistance to moisture and that it also provides excellent resistance to mechanical damage during subsequent processing, particularly during final assembly (which is understood to include solder reflow for bonding of metal connections), as taught by Costas.

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to John Ruggles whose telephone number is 703-305-7035. The examiner can normally be reached on Monday-Thursday and alternate Fridays.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Mark Huff can be reached on 703-308-2464. The fax phone number for the organization where this application or proceeding is assigned is (703) 872-9306.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is 703-308-0661.

MARK F. HUFF
SUPERVISORY PATENT EXAMINER
TECHNOLOGY CENTER 1700

John Ruggles
Examiner
Art Unit 1756